Acquisition

reform week III

Open systems concepts & Application to dod weapon systems

Facilitator Guide

Acquisition Reform Week III
Open Systems Concepts & Application to DoD Weapon Systems

Scope of Seminar

This seminar addresses the Open Systems Approach (OSA) to weapons system design, one of the centerpieces of DoD acquisition reform. The seminar focuses on the OSA as an integrated technical and business strategy that defines key interfaces for a weapon system and facilitates the use of standards widely supported and used by commercial industry. It is an innovative way of doing business, which allows program managers the flexibility to leverage the creativity and competitive pressures of the commercial marketplace to find less costly solutions for weapon systems. One of the objectives of the seminar is to highlight new techniques for designing weapons systems using an Open Systems Approach. A short exercise has been included in the seminar where participants will select a standard interface for a system using the concepts and techniques taught in the seminar. *

Instructions to Facilitators

Each Acquisition Reform Week III seminar takes approximately one and one-half hours to complete. To maximize the potential for participants to gain an overall understanding of the subject, we suggest you hand out presentation materials 2-to-24 hours in advance. If participants read the information before the seminar, the facilitator can conduct a brief recap and then devote a significant portion of the time to practical experience such as exercises, e.g. working through the scenario which demonstrates the principles outlined in the presentation.

As Facilitator you will need a copy of the full package which is detailed below. Participants should receive item #2 in advance, if possible: item #3 should be handed out in the seminar. Items #1 and #4 are for the exclusive use of the Facilitator.

Included in this file are the following:

TIP: Print pages in the order noted so you will have one complete package. Then, duplicate individual sections as needed depending on number of participants. This will ensure materials are in correct order and will reduce the risk of the file being too large for computer or printer equipment to handle with ease.

Main Teaching Points

These are the four main teaching points in this seminar. Before proceeding to the practice session, make sure participants understand the following:

1. The basic terms and concepts of Open Systems.

2. The potential benefits and challenges of using Open Systems.

3. The practical skills associated with an Open System Approach in the DoD acquisition process.

4. How program life-cycle economics can benefit from the implementation of Open Systems.

*This seminar was tailored from materials used in the 2 ½ day Open Systems Concepts and Application to DoD Weapon Systems Workshop, developed and presented by the BRTRC Institute for Open Systems Joint Task Force. For more information please contact (703) 205-1593, or visit our website at: http://institute.brtrc.com.

Overview and Presentation for Participants

Acquisition Reform Week III
Open Systems Concepts & Application to DoD Weapon Systems

Overview
Welcome to the Acquisition Reform Week III seminar, Open Systems Concepts and Application to DoD Weapon Systems. This session is designed to help participants do the following:

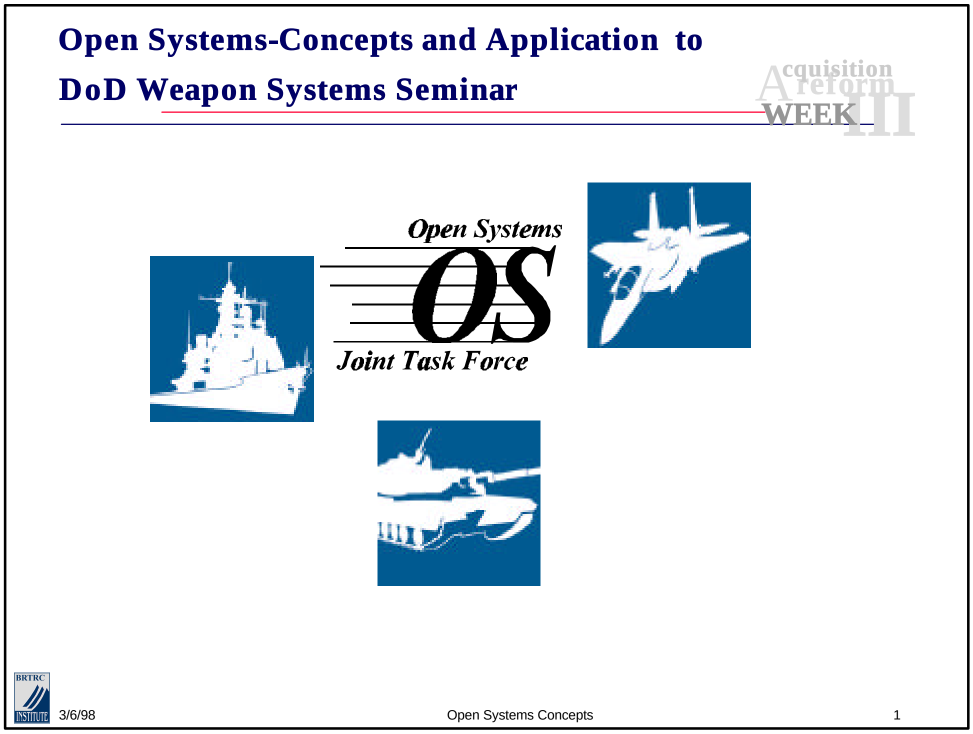
1. Understand basic terms and concepts of Open Systems.
2. Be able to describe and discuss potential benefits and challenges of using Open Systems.
3. Refine practical skills using an Open Systems Approach in the DoD acquisition process.
4. Know how program life-cycle economics can benefit from the implementation of Open Systems.

Exercise Objective
The focus of this exercise is to apply interface standards selection criteria, perform risk assessment, and use technical and business considerations to develop a portion of a system architecture. Participants will work in small groups to analyze, rank, select and justify interfaces appropriate for system requirements, timeliness and cost.

This exercise reinforces material in Open Systems Approach. It emphasizes the importance of selecting appropriate interface standards and illustrates risk management aspects inherent in good Open Systems design.

This block allows participants to examine a number of different interfaces that meet requirements of specific and innovative technology. Satisfactory completion of this training material requires a complete understanding of the major issues pertaining to Open Systems Approach as presented in the seminar.

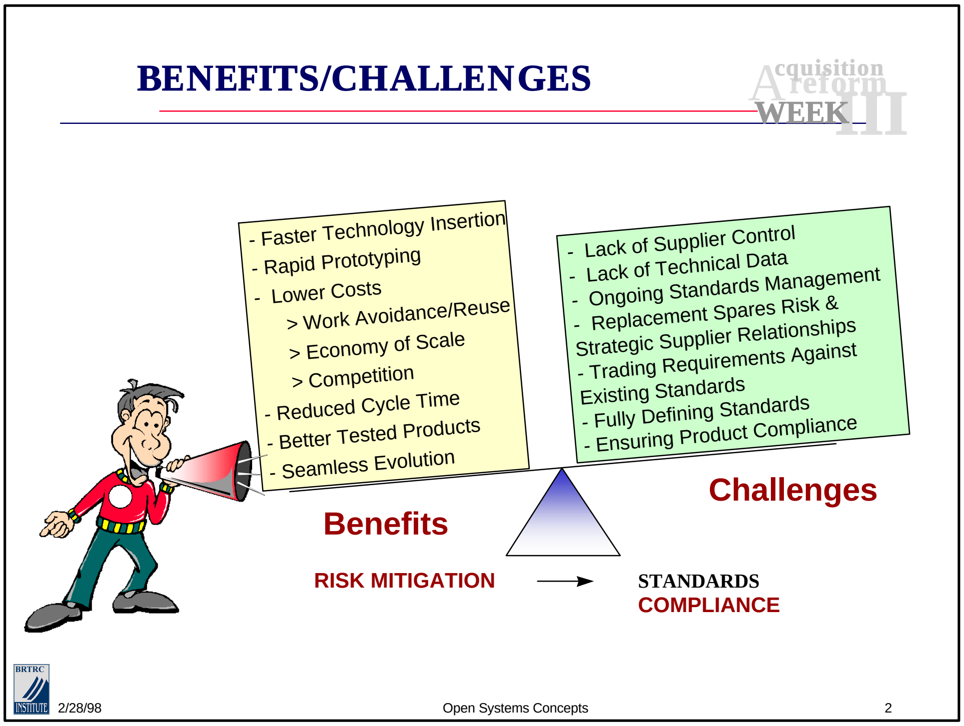
Instructions to Participants
Please review the presentation. Be prepared to ask questions and/or participate in a brief recap. This will be followed by a practice session which will test your understanding of the principles captured in the presentation material and give you hands-on experience in dealing with applying best Open Systems Approach techniques.



The Open Systems Approach (OSA) is an integrated technical and business strategy that defines key interfaces for a system or piece of equipment that is being developed.

OSA is a new way of doing business for DoD, and an important part of Acquisition Reform. Hard pressed to maintain the superiority of U.S. military systems within severe budget constraints, DoD program managers need the flexibility of open systems to leverage the creativity and competitive pressures of the commercial marketplace.

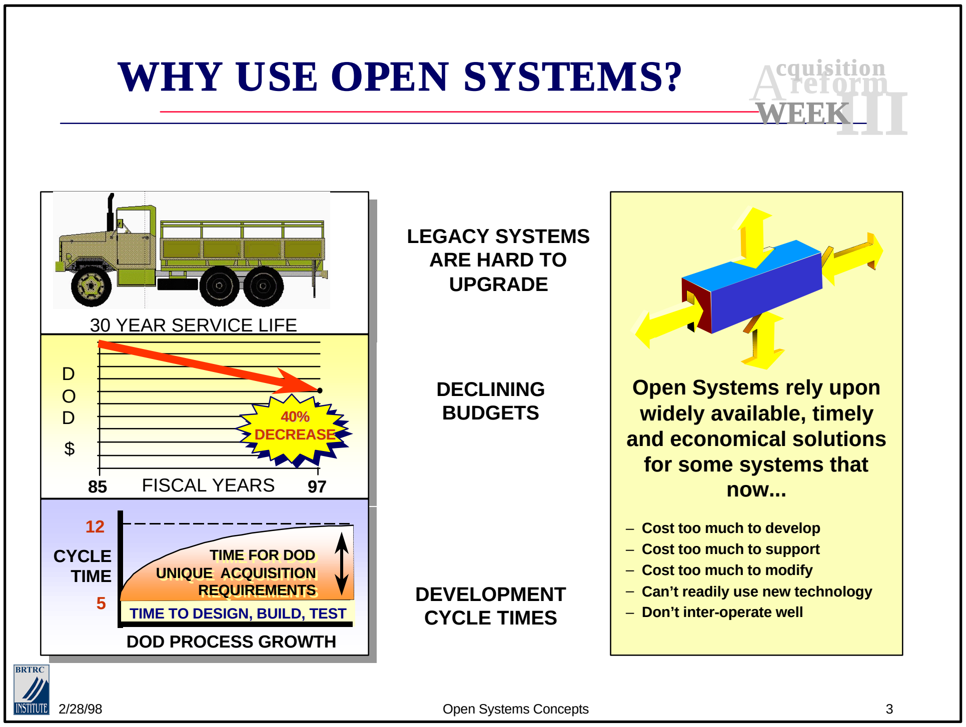
During this seminar we will discuss the basics of the OSA.



This slide illustrates what we're going to concentrate on during this seminar--the benefits and challenges of applying an OSA. After we have discussed the lecture slides, we have a brief exercise to illustrate the basics of selecting an Open System for a weapon system.

Weapon systems present unique challenges to implementing an OSA. Perhaps the greatest challenge lies in applying the concept to legacy systems where "closed or proprietary" designs and inflexible infrastructures make it difficult to integrate new components. Also, the harsh environment in which our weapon systems operate may make it difficult to use commercial components.

The open systems approach is neither a panacea nor risk free. The types of risks experienced by the program are different than those experienced by traditional acquisition approaches because our control over the system development has changed. The open systems approach is a combined business and engineering strategy where engineering decisions are driven by business considerations. The program leadership must weigh the potential benefits against the risks in making the "buy versus build" decision.



Weapon systems expense reflects in part their 'closed' designs that are based on non-standard interfaces which are typically supported by only a few suppliers. Having only a few suppliers limits competition and tends to increase costs and the possibility of obsolescence.

An OSA, on the other hand, bases the weapons system's design on open, commercially supported interface standards with the prospects of a large supplier and customer base.

Legacy Systems Are Hard to Upgrade:

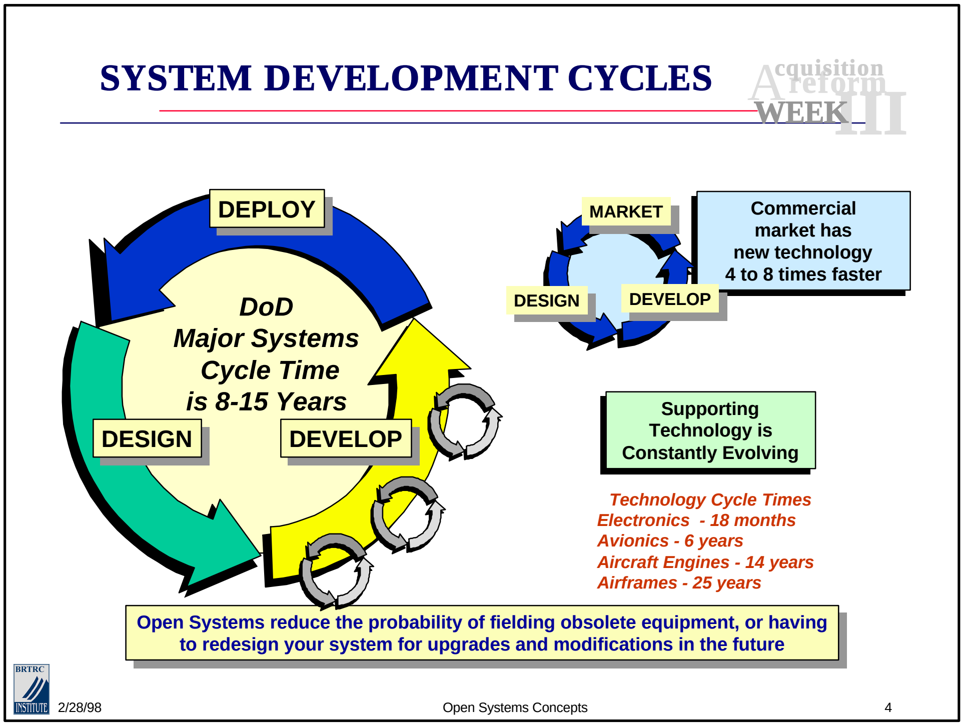
…OSA facilitates technology insertion

Declining Budgets:

…OSA can reduce cost through competition via many suppliers

Development Cycle:

…OSA can shorten the development cycle



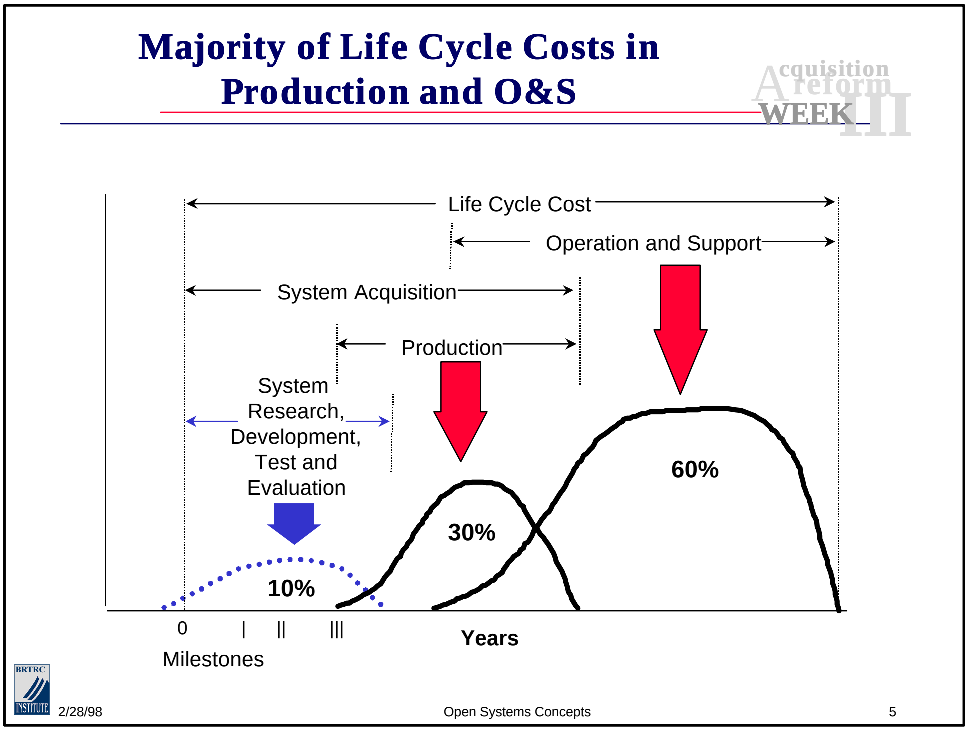
- OS allows products to fit inside and update functions as time goes on.

- Open systems are important because it helps cut cycle times and facilitates technology infusion. DoD weapons systems development time ranges from 8 to 15 years. By contrast, the average commercial sector brings new products to market in about half that time. In the area of electronics, the commercial market develops new technology four to eight times faster than the normal weapons system development cycle. DoD cannot afford to be 3 or 4 generations behind the commercial market.

- When cycle time grows beyond a certain point, the fact that technology changes over time becomes a significant factor. Beyond a certain cycle time, we end up fielding systems with obsolete technology on the very first item off the production line.

- The military also needs the ability to integrate new technology into legacy weapons systems. OSA provides this capability.

- We maintain systems for 20 to 40 years. Open systems allows us to upgrade these systems at relatively low cost. The result is a superior system over the total life cycle at a lower cost to the government

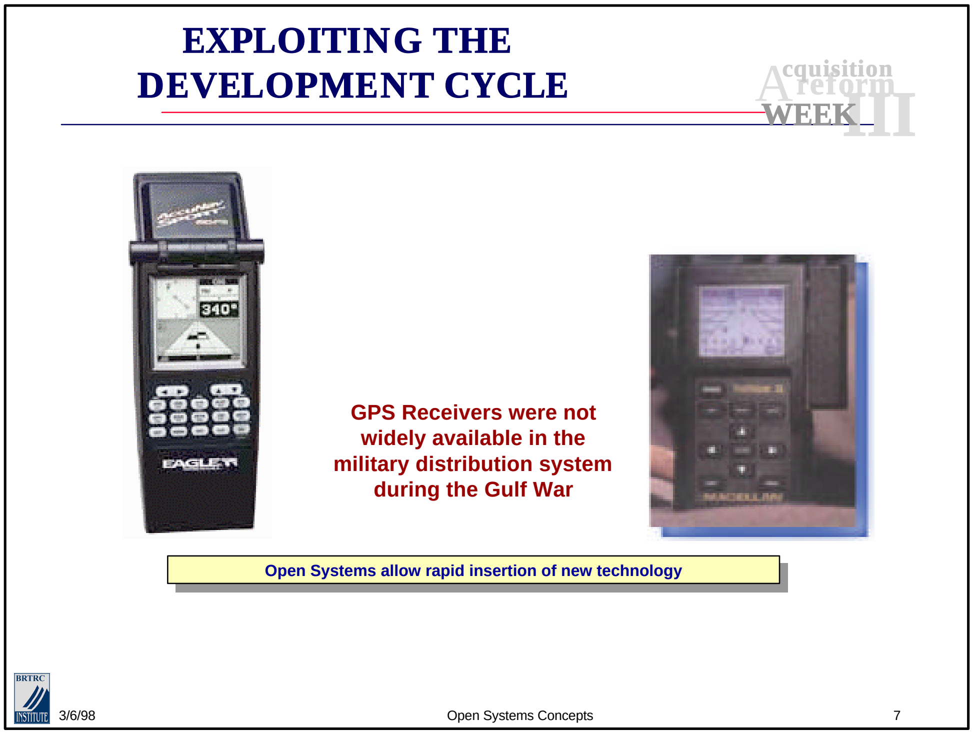


Longer system life times aggravate an already apparent problem in the long term affordability of weapon systems, as indicated in the O&S phase shown in the above figure. In total, 28% of life cycle costs are incurred prior to IOC, whereas 72% of the life cycle cost is incurred during the service lifetime [from 6/12/96 briefing by Principal Assistant Deputy Under Secretary of Defense for Logistics, Mr. Roy Willis].

We typically concentrate on the short term when we deal with a product. We concentrate on having the lowest development costs possible. Referring to the above figure, it is clear we should concentrate on doing things in development that will decrease costs during production and especially during O&S.

An open systems approach focuses on system life cycle supportability by considering life cycle support requirements up front, permitting system evolution with technology development, anticipating technology obsolescence in system design and by supporting technology insertion.

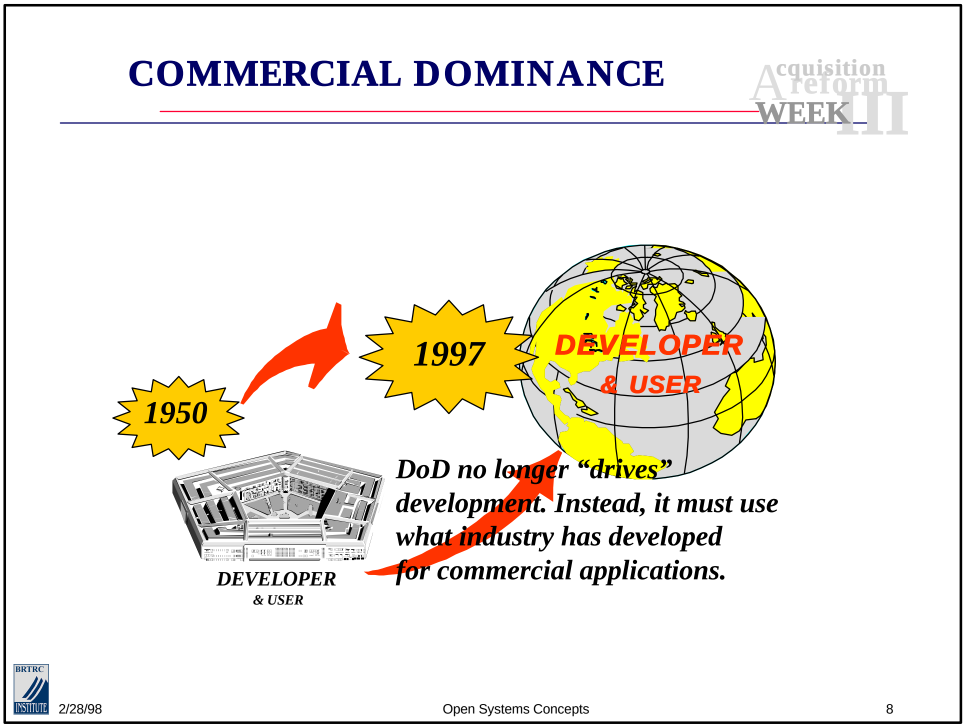
As DoD limits the number of new weapon systems procurements, it is also extending the life of the systems currently fielded some up to. A 30-50 year service lifetime. Examples include the UH-1 Helicopter, B-52 Bomber, Hawk Missile, AIM-9 Missile, C-130 Aircraft, M-113 Armored Personnel Carrier, SSN 688 Submarine. An open systems approach specifically addresses issues of affordability and supportability associated with long system life times.



- The shift from DoD directed-development to applications developed for and by industry requires a major re-orientation of our thinking about requirements, not only in the electronics arena but throughout our approach to performance specifications to meet military needs for technology infusion.

- One example of how industry provided a solution when an open standard was available:

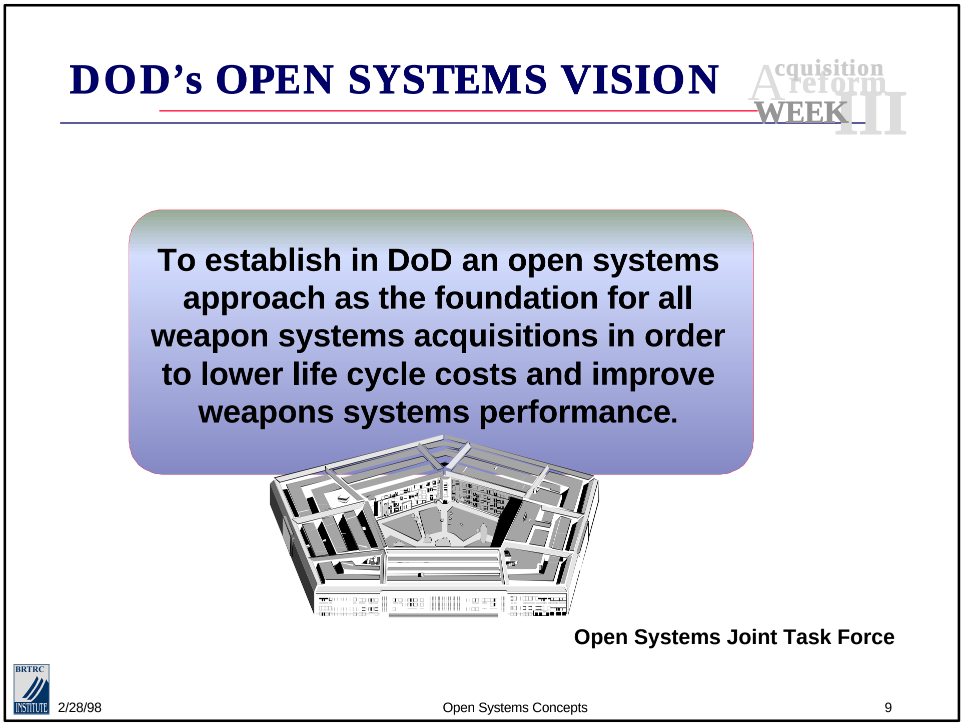
  – At the time of Desert Storm, a MILSPEC GPS receiver cost $34,000 each and weighed 17 pounds. The procurement lead time was 18 months. The Army purchased commercial GPS receivers weighing 3 pounds that cost $1,300.



Another reason that open systems have become a priority is that the market place has changed. In the 1950's, DoD was the dominant force in the market place. DoD requirements drove development of new products and new technology. In the 1990's, the opposite is true; commercial demand drives product and technology development.

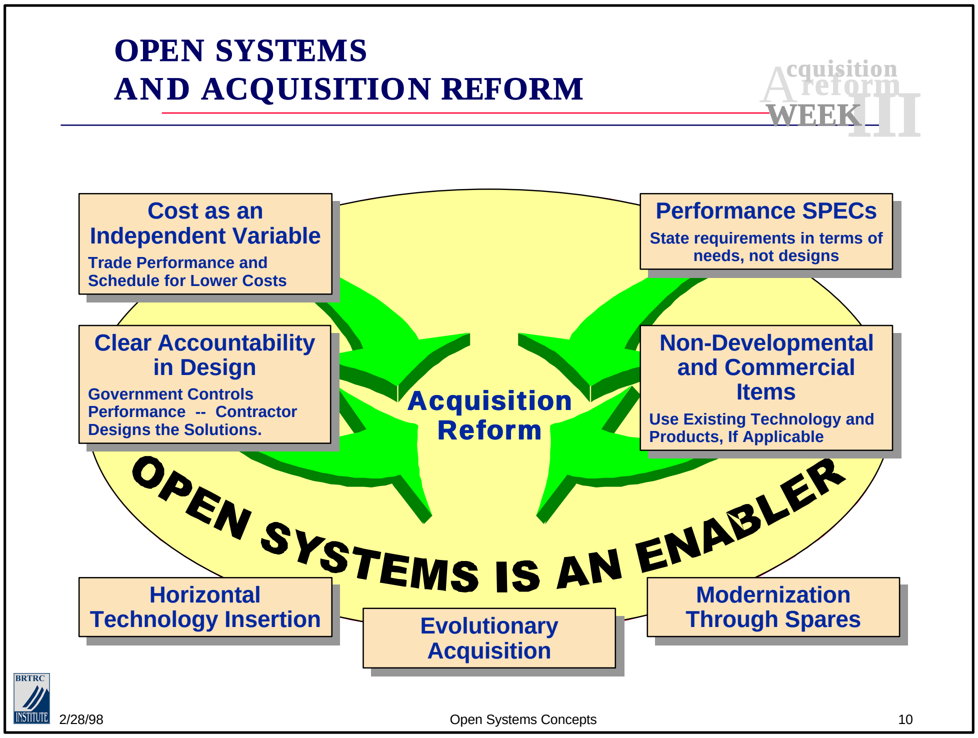
DoD can take advantage of commercial innovation, research and development to drive down the cost of developing, acquiring and maintaining weapons systems. Rather than relying on unique, expensive programs, DoD can leverage the commercial investment to make the most of available and shrinking defense funds.

The open systems approach achieves this effect by designing systems to use open, widely supported standards and interfaces (e.g., commercial). The cost benefits accrued depend on how widespread the standard is supported in the market, and how widely the standard is used within a weapon systems domain (e.g., avionics, ground vehicles, missiles, soldier systems and marine).



Some of the keys to achieving DoD's vision include:

- Assure the DoD acquisition workforce understand open systems and know how to implement it
- Assure industry and standards bodies are aware of the policy and new opportunities
- Identify opportunities for open systems architectures
- Share lessons learned
- Establish key interface standards for use in weapon systems
- Integrate open systems with other DoD policies and initiatives
- Establish the open systems in continuing practice across the DoD



How does Open Systems relate to other acquisition reform initiatives?

The open systems approach is an “ENABLER”.   It:

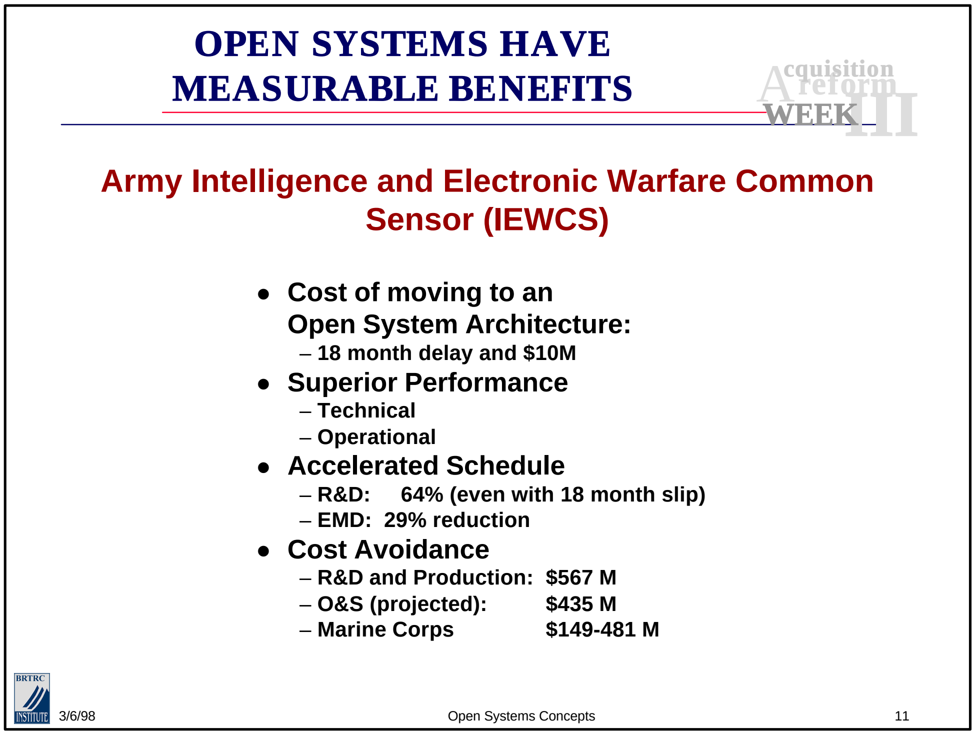
- Enables Cost as an Independent Variable (CAIV) by emphasizing the importance of selecting interface standards which support affordable systems evolution.

- Supports commercial items and NDI initiatives by using standards-based interfaces supported by these products.

- Supports Modernization Through Spares, Horizontal Technology Insertion and Evolutionary Acquisition by promoting the use of standards-based interfaces based on widely supported standards and focusing DoD’s engineering and management of weapons systems “at the interface.”

- Enables Horizontal Technology Insertion by promoting the use of standards-based interfaces across weapons systems domain and their product lines.

Finally, open system interfaces specifications are, in fact, Performance Specifications at the interface and their use is consistent with the Performance Specifications initiative.



An OSA success story. The cost of moving to an OSA was 18 month program delay and $10M. A few key results were:

- Better performance: increased frequency range and speed/precision.
- Each configuration can perform all of the missions.
- All configurations use commonly fielded vehicles, saving O&S costs. Compared to its predecessor, it requires 46 percent fewer operators, 65 percent fewer vehicles, and 60 percent less airlift
- Reduced research and development time by 64 percent, despite the 18 months slip to initiate the OSA
- Reduced engineering and manufacturing development time by approximately 29 percent R&D. Given an estimated total R&D and production costs of approximately $845 million, the estimated cost avoidance for these two life-cycle phases alone is approximately $567 million.
- O&S. When combined with an estimated cost avoidance for the O&S phase of approximately $436 million, the OSA-based IEWCS acquisition represents a cost avoidance to the Army of over $1 billion.

POSSIBLE RISKS

Acquisition Reform WEEK III

- Government becomes a consumer instead of the designer - less control over outcomes
- Open Systems may not provide the optimum design for modules, components, subsystems and short-term solutions
- Building Open Systems takes time for
  - Market analysis
  - Prototyping
  - Standards Selection
- The standards selection process has risks
- Open Interface *extensions* may cause problems later in the life cycle
- Open Systems may or may not be appropriate for legacy systems

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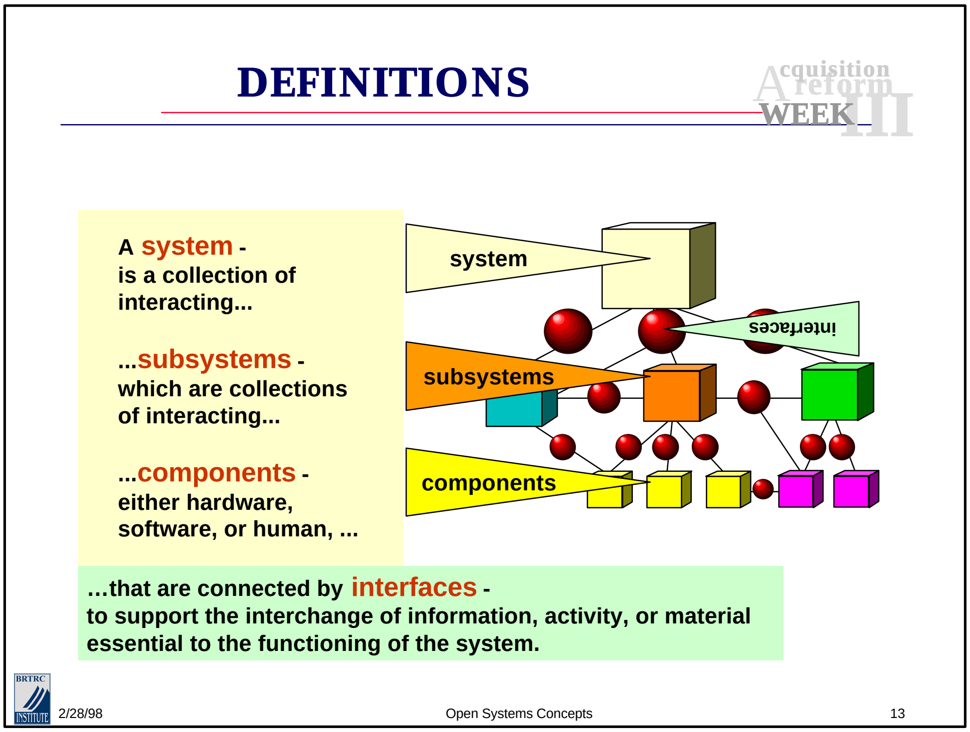
There are risks to manage with an OSA. They result primarily from our loss of control over the detailed design of the system.

With an OSA, our vantage point is now the “interface” to the component as opposed to having detailed knowledge and control over design. Without this level of control there are a number of “performance risks” considerations: can standards-based components survive the environment? Are they reliable? Can they satisfy special performance requirements such as fault tolerance, security, real time, is there BIT?

One key risk is picking the correct standard. An ongoing DoD effort has workgroups examining existing commercial standards and working to select appropriate ones to use. In some cases, such as the Information Technology area, this work is nearing completion, and mandatory standards are being published within DoD.

Being part of a larger market we may have little influence over the vendor. Frequent configuration changes with little or no warning, could add unreasonable burden to configuration management efforts. Obsolescence risk can be minimized by ensuring that selected interface standards have wide market support and that there is a strategy for interface upgrade.



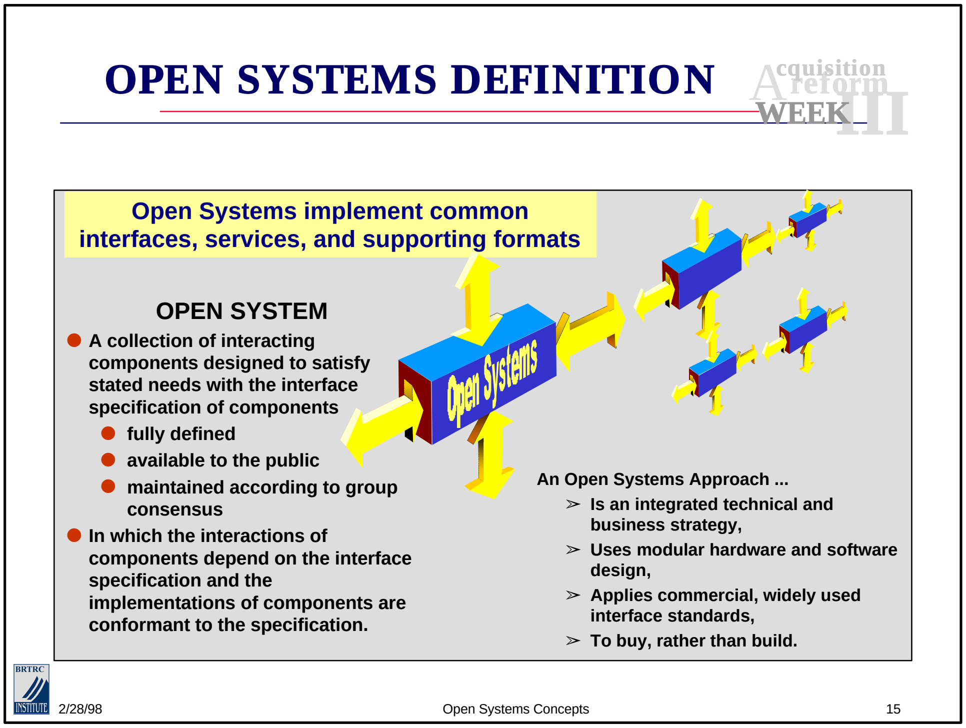
It is important to understand the terms used in Open Systems. Unfortunately, many of the terms that we will use have numerous definitions and usage. Therefore, we will spend some time initially discussing the definition of terms we will use to aid in our mutual understanding.

For the purpose of this discussion, systems are comprised of subsystems which are, in turn, comprised of components where each is separated by well defined interfaces.

An interface is the shared boundary or connection between two or more components. Interfaces support the interchange of information, activity or material essential to the functioning of the system. Interfaces may be described by their electrical, mechanical, functional or procedural characteristics. Often, interfaces are described in terms of "form and fit" (F^2I), or "form, fit and function" (F^3I).

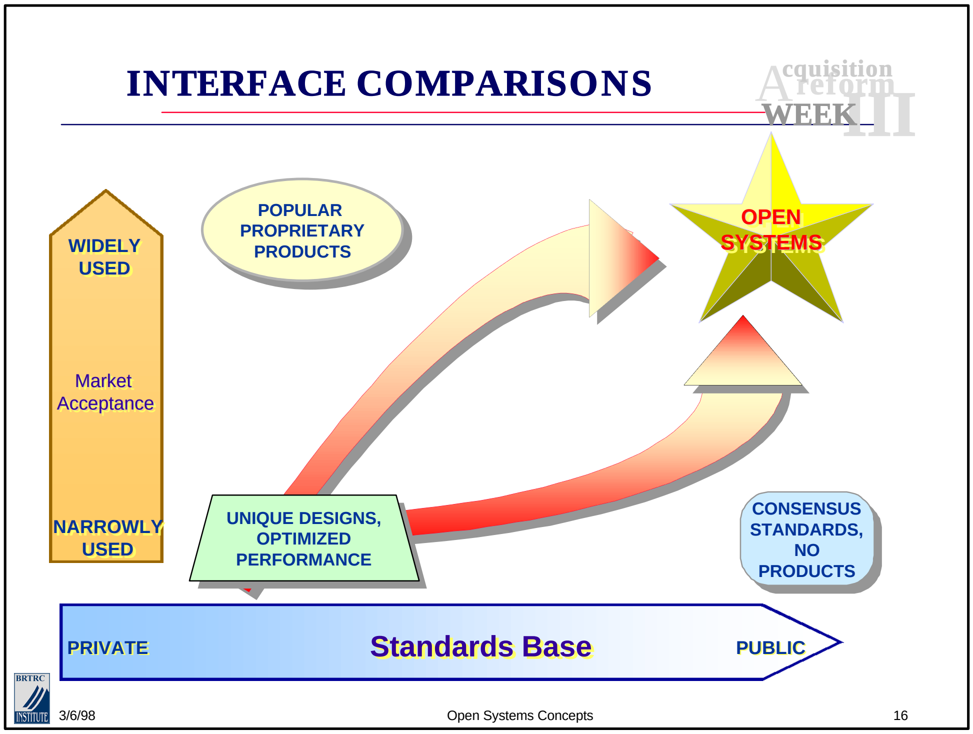
An open systems approach applies widely used interface standards to F^2I and F^3I interfaces. An interface standard is a standard that specifies the physical, functional, or military operational environment interface characteristics of systems, subsystems, equipment, assemblies, components, items or parts to permit interchangeability, interconnection, compatibility or communications (MIL-STD-962C).

The success of the open systems approach depends, in large part, on how well system interfaces are defined and managed.



One definition adopted by DoD: A system that implements sufficient open specifications for interfaces, services, and supporting formats to enable properly engineered components to be utilized across a wide range of systems with minimal changes, to interoperate with other components, and to interact with users in a style which facilitates portability. An open system is characterized by the following:

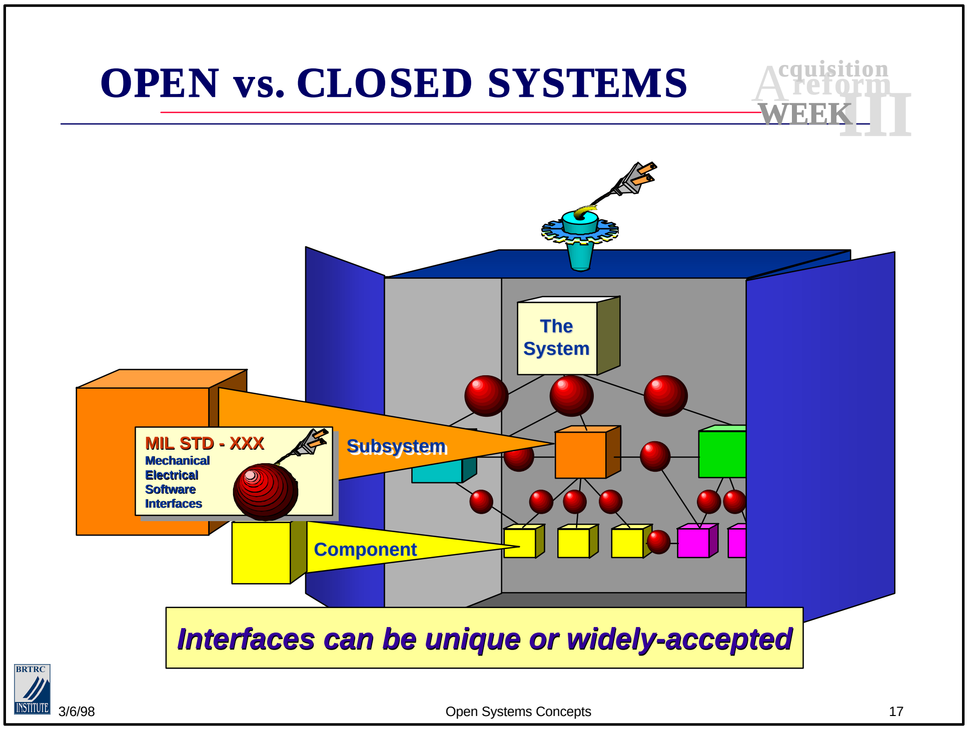
- Well defined, widely used preferably non-proprietary interfaces/protocols, and
- Use of standards which are developed/adopted by industrially recognized standards bodies or the commercial market place, and
- Definition of all aspects of system interfaces to facilitate new or additional systems capabilities for a wide range of applications, and
- Explicit provision for expansion or upgrading through the incorporation of additional or higher performance elements with minimal impact on the system.



Two important “consensus” criteria by which to measure products based on standards are their openness in terms of formal acceptance, measured on the horizontal axis in the figure shown, and their openness in terms of market acceptance, measured on the vertical axis.

Our goal is to avoid the closed systems that are narrowly used, in the lower left corner, and use products that have both wide market acceptance and formal acceptance. Popular proprietary systems, such as Microsoft Windows 95, are an example of de facto standards having wide market acceptance that can have a use in DoD.

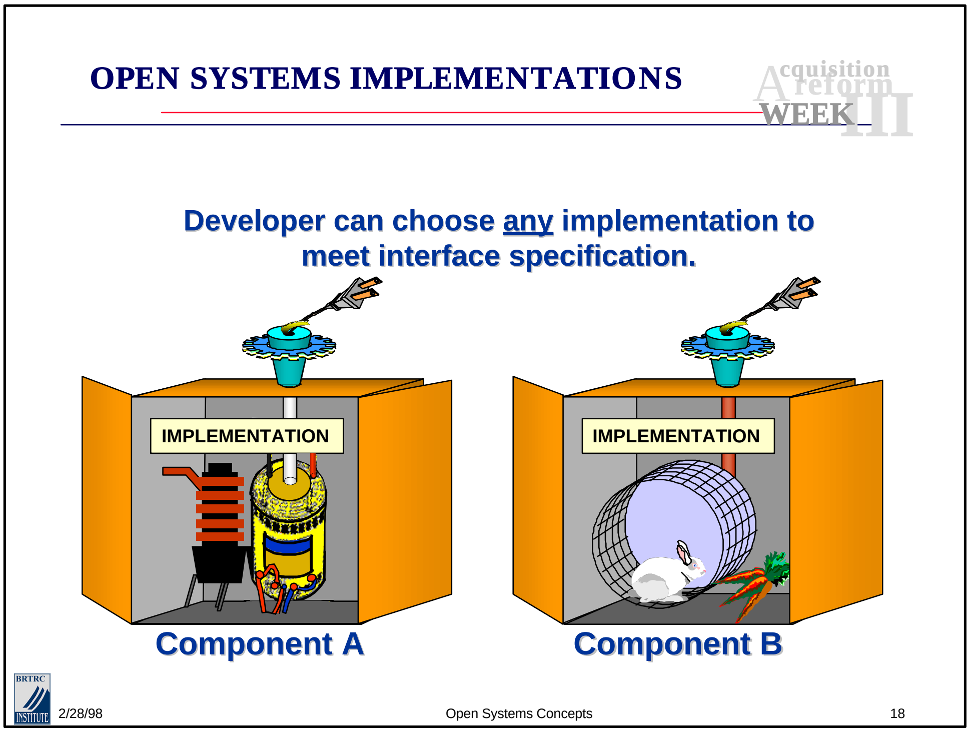
Another important measure is performance. Does the particular standard allow the system to meet its performance requirement, now or in the future? Does the standard allow the system to meet its “growing” performance requirements?



By comparison, closed systems are characterized as systems having closed interfaces for the majority of their system's interfaces. We will define closed interfaces as being either unique or proprietary or system-specific. Closed systems are usually referred to as being "stovepiped," where the same closed interfaces are usually used within a particular weapon systems domain (e.g., avionics, missiles, ground vehicles, submarines, etc.)

Also, note that open systems may not have all open interfaces. There may be instances within an "open system" where interfaces are closed or are "partially" open. Closed interfaces are used when there are no suitable open interfaces that can meet the performance requirements. "Partially" open interfaces are interfaces based on open standards which have been extended or modified in some manner to meet certain performance requirements and, therefore, have limited or narrowed their original market support.

A challenge in applying an open systems approach is to find widely supported interfaces that also satisfy demanding weapon systems performance requirements which are often dictated by the severe environmental conditions in which our systems operate. Another challenge is to consider modulating requirements to allow the use of standards-based interfaces. This may require meeting less than 100% of requirements or re-allocating requirements to other components within the system.

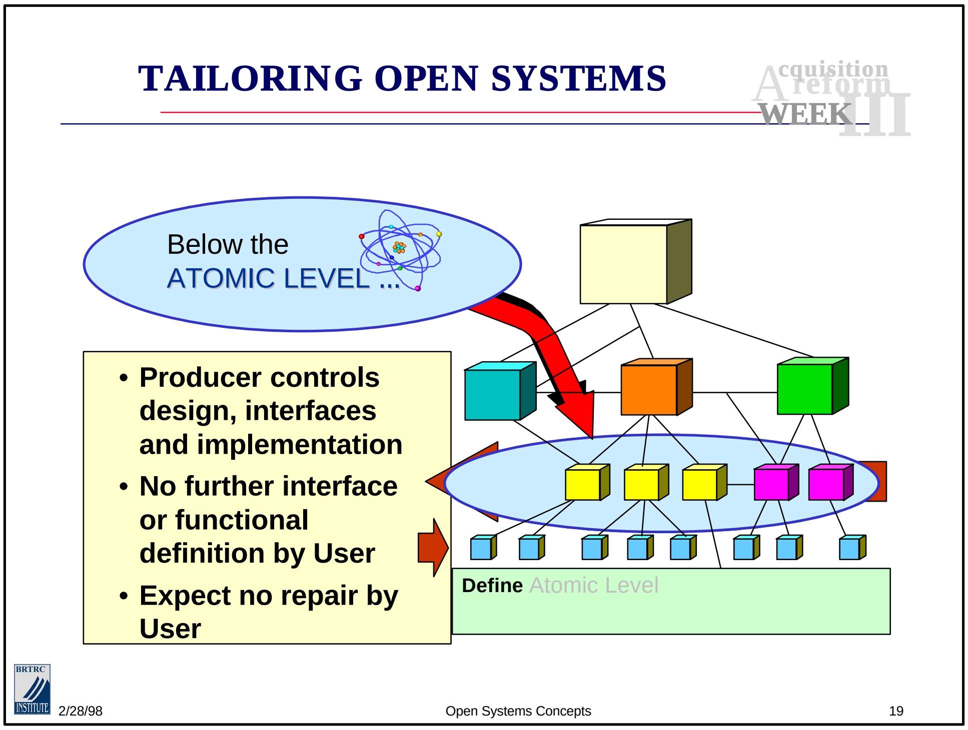


Implementations involve the “how to” or detailed design of a particular component or subsystem. Current acquisition policy is for DoD to describe the performance of the desired system (i.e., performance specifications) and not specify “how to” build it. Open systems interface specifications are often confused as being “detailed” or “how to” specifications when they are actually “performance specifications” for the interface.

Many different implementations may be available in the marketplace that meet a particular component’s performance requirements. Take care to ensure that the implementation procured conforms to the (open) interface specification for the system.

Open systems components conform to standard interfaces, even though the implementation may be proprietary.

An important aspect of open systems is that open interface standards allow industry to use innovative, often proprietary, technical solutions internally that keep their products competitive. Ideally, this drive by manufacturers to continually differentiate their product in the marketplace provides DoD with continually upgraded products from multiple sources of supply.

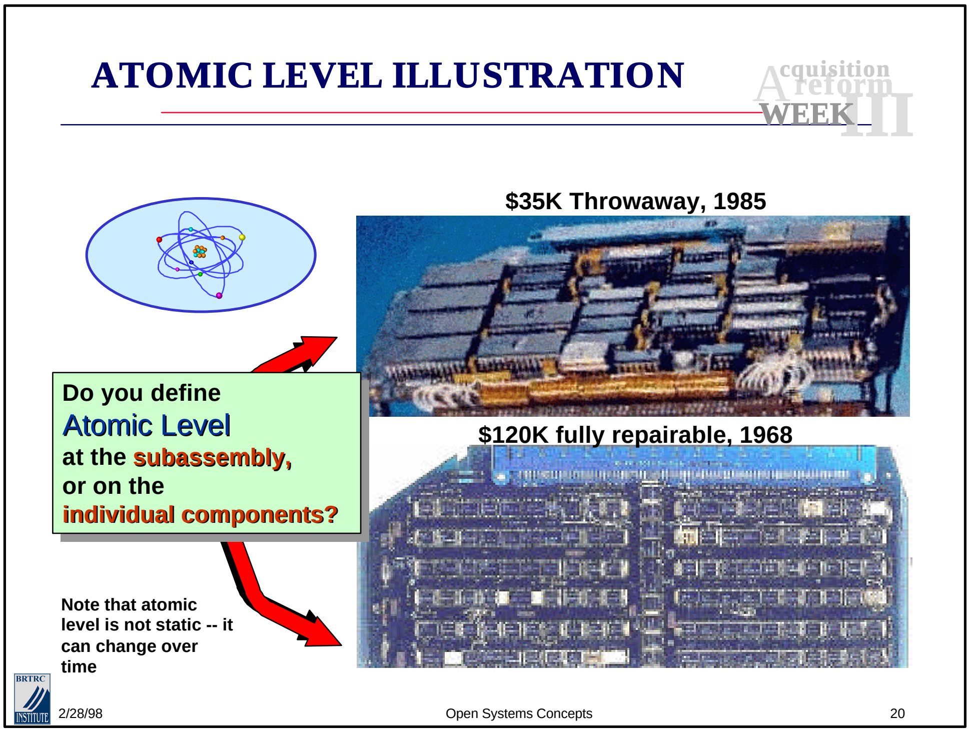


Where within the system are interface standards important to us?

The atomic level is defined as the level at which you intend to repair your system (e.g., lowest repairable unit, LRU). Above this level, the government controls the interface. Below this level, there is no organic repair and the details of the implementation and lower level interfaces are left to the manufacturer.

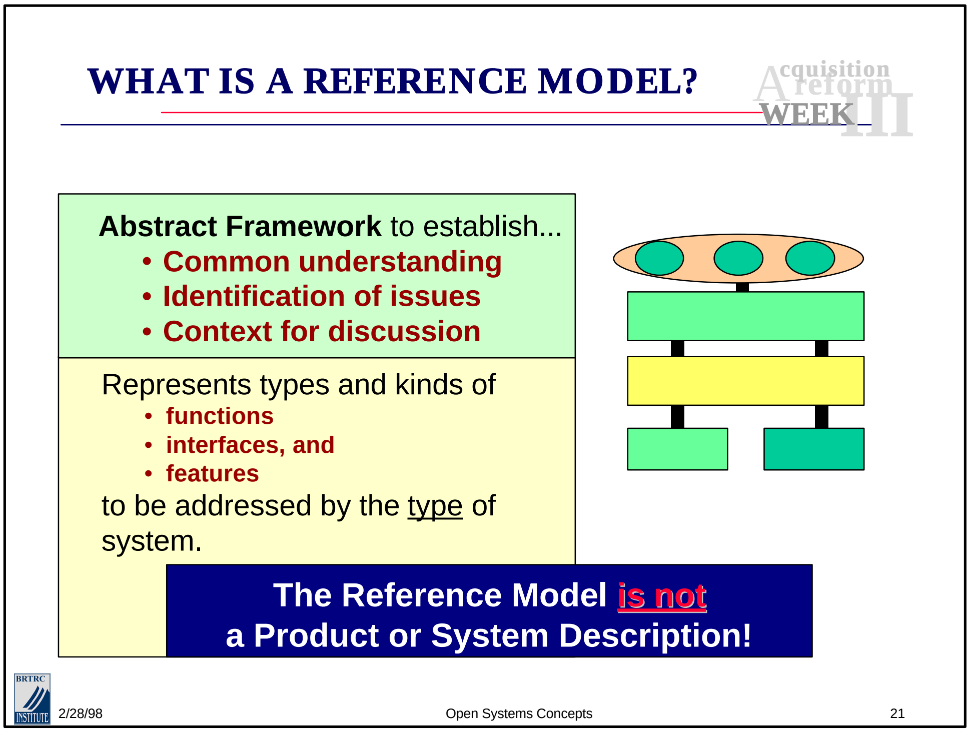
Choose the atomic level and associated standards based on:

- Anticipated Life Cycle Cost drivers
- The impact of rapidly changing technology on system components
- The likelihood of components evolving or growing in capability over the life of the system
- Performance, risk & business considerations



Note that atomic level may vary throughout the system and may change over time. The atomic level should reflect the system's plan for evolution over time. Defining the atomic level too low may limit efficient technology insertion, while defining the atomic level too high may lead to the use of proprietary interfaces for major system components resulting in limited supplier support.

In the figure shown, we can see the impact of technology advances on the atomic level. Where DoD once repaired circuit cards at the "chip" level, it is now more common to repair at the circuit board or higher. Advances in technology (increases in system processing power and communications capacity) are allowing systems engineers to build systems with fewer instances where system resources (e.g., processors and communications capacity) are dedicated to particular applications to ensure real-time, fault tolerance services over distributed, fully connected systems. Instead, system resources are being allocated dynamically, as needed. As a result, system architectures are shifting away from federated systems to more integrated systems. As a result, the atomic level move higher away from lower level interfaces tied to application-specific components

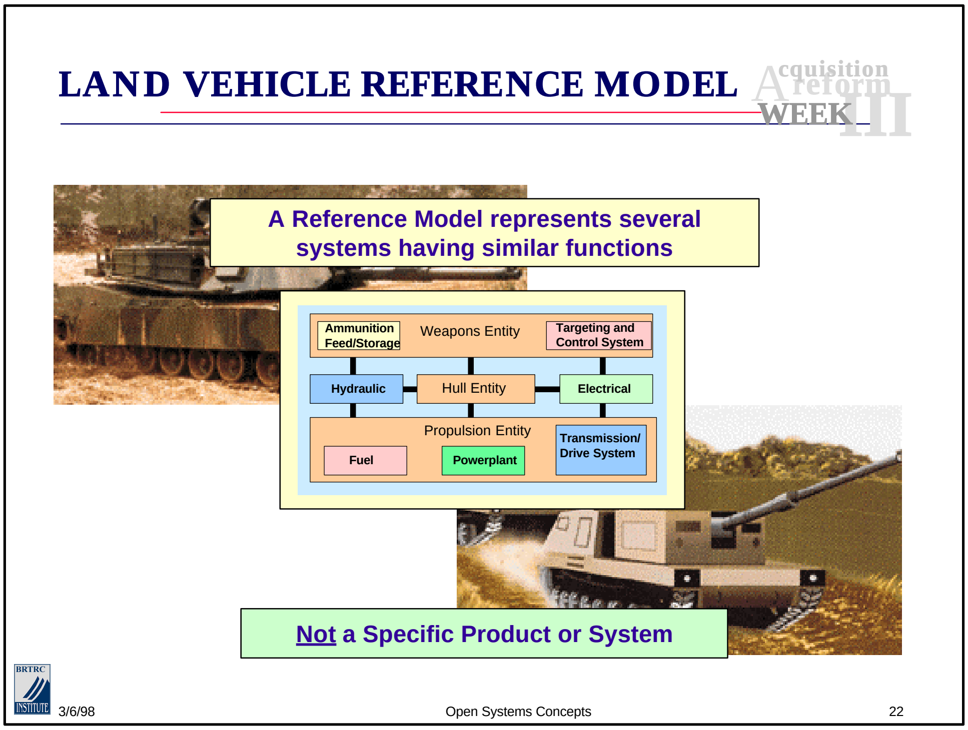


A reference model provides a high level, generalized system view of the weapon system family. A reference model is intentionally generalized and does not imply any specific system implementation. Its purpose is to provide a common conceptual framework, and define a common vocabulary so that diverse components within the domain can better coordinate acquisition, development and support of domain systems. A reference model:

Provides a framework for how to apply standards. Particularly, how to identify interfaces critical to achieving system technical and business goals. Reference models establish a context for understanding how disparate technologies and standards relate to each other.

Embodies the earliest set of design decisions. The reference model is important because it is a common high-level communications vehicle for system stakeholders.

Specifies the atomic level. The reference model forms the organizational plan for development. It forms the basis for specification of the repairable (atomic) level of the system and becomes the foundation for product line development. Well-formed reference models exhibit modularity. A reference model begins the breakout of the subsystems.

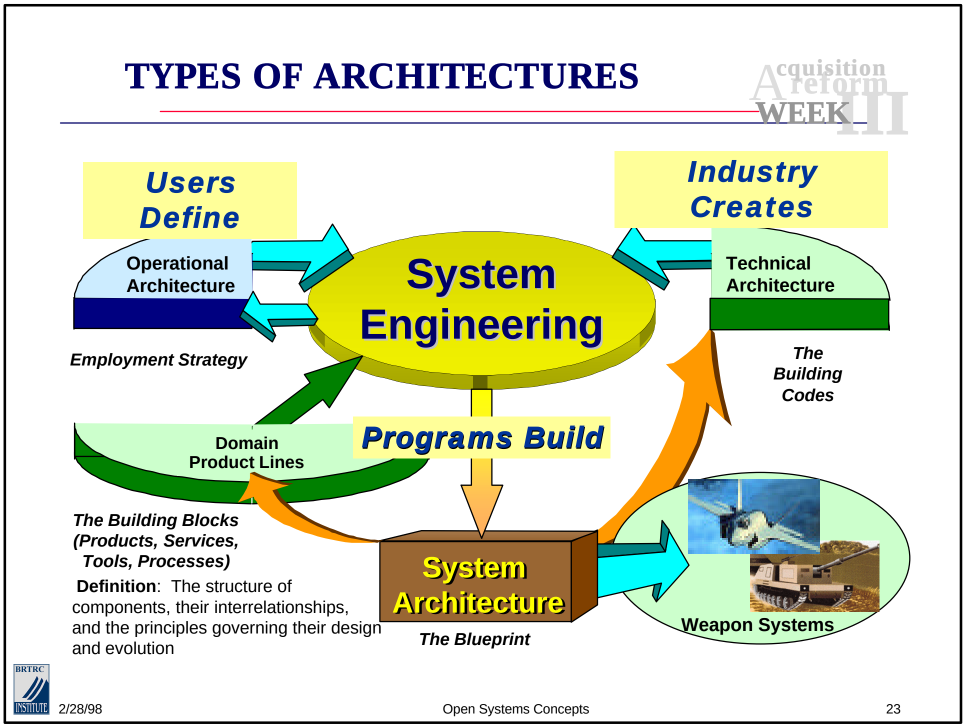


As an abstract description, a reference model can apply to a number of different systems. It is not a specific system. Here we examine a land vehicle reference model.

The reference model provides a framework for the discussion of the connectivity of the system entities. It is associated with a domain of interest (scope of functionality).

In some cases, DoD workgroups have established standard reference models. For example, there is a technical reference model for information technology in the Joint Technical Architecture, based on a commercial model. Joint Technical Architecture version 1.0, Aug '96. Version 2.0 is being worked, scheduled for Mar '98)

Joint Weapon Systems Technical Architecture Working Group (JWSTA WG) is the group who chooses weapons domain specific standards for inclusion in Weapon Systems annex. All other IT standards chosen in CORE standards. Standards are chosen to mitigate risk. Standards are scrubbed with each interaction of the document. The standards are updated on a regular basis. Need to be able to specify that contractor must stay current with mandated standards, or have a plan for migration to new standards as they occur.

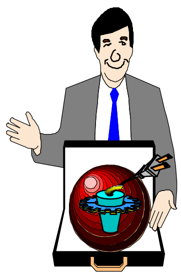


The Operational Architecture specifies the "user requirements," i.e., three bedrooms, 2 baths, a one-car garage. The Technical Architecture constrains the system's design during the systems engineering process--our building codes. The System Architecture emerges as an output to the systems engineering process and is constructed to satisfy Operational Architecture requirements per the standards defined in the Technical Architecture.

In the housing industry, for example, the "technical architecture" is the set of building codes to which houses are built. The list of standards that is designated for DoD weapons systems use essentially forms a technical architecture that DoD program managers use in developing their "system architectures." Again, in the housing industry the "system architecture" is the blueprint for the house that is to be built. Just as blueprints must conform to the building codes, DoD weapon systems system architectures must conform to the list of standards designated for their use. Continuing with the housing industry analogy, much as the operational architecture would reflect the image of a house that the home owner would expect to view when choosing what kind of house to buy, the weapon system's operational architecture would reflect satisfying those requirements that it was designed to meet.

OPEN SYSTEMS EDUCATION

- Educate your managers, system engineers, procurement specialists, developers, users,...
- Open systems represent a new vocabulary and different perspectives -- another paradigm shift
  - **Corporate Management**
    - Enabler for your project/organization to cross traditional boundaries
    - Corporate management with business-related decisions needs to participate in procurement and life-cycle management policy
    - Buy, grow, or affiliate technology and open systems expertise
  - **Program Management**
    - Procurement priorities, life cycle management, system profile specification, conformance testing, and system migration may be new
    - **Technical Management**
    - Open interface profiling, defining conformance testing , evaluating Commercial Item openness, interoperability testing are different from developing and designing unique, optimum solutions.



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Education in open systems is critical. It is critical that there be no problem separating the marketing "hype" of open systems from the realities of open systems at all levels of management, development,... participation.

It is difficult to effectively manage complex technical change when the change crosses traditional organizational, and technical boundaries. The determination of the appropriate specific interfaces will be based on the consensus reached by different functionality, crossing traditional organizational boundaries.

Education allows participants to understand the underlying motivation, and basis, and provides participants with an opportunity to make needed contributions. Participants generally know their systems functions and configurations better than anyone and will be the individuals who actually make the changes to the systems.

THE OPEN SYSTEMS JOINT TASK FORCE

Acquisition reform WEEK III

- **Established by the Office of the Undersecretary of Defense for Acquisition and Technology**
- **The Open Systems Joint Task Force (OS-JTF) was formed in September 1994 to:**
  - **"Sponsor and accelerate the adoption of open systems in weapons systems and subsystems electronics to reduce life-cycle costs and facilitate effective weapon system intra- and interoperability."**

- **OSJTF Web Site has more information http://www.acq.osd.mil/osjtf/**
- **e-mail: osjtf@acq.osd.mil**
- **Phone: (703)578-6141**
- **FAX: (703)575-0534**

Discussion / Exercise Tasks

Open Systems Concepts

Acquisition

Reform

Week

III

This presentation has described the concepts and principles applied in using an OSA. Examples of particular weapons system programs have been used to illustrate the application of open systems principles to achieve cost, schedule and performance benefits by promoting multiple sources of supply and technology insertion.

Exercise - Selecting Standards

Situation: You are specifying interfaces on a modification of automated test equipment for the Navy's F/A -18 E/F. Although this is a new aircraft, it will employ existing servicing and test equipment to the maximum extent practical.
The tester you are working on now is used with F/A-18 C/D models, and has a modular design. One module is a militarized computer meeting some of the architectures of the commercial Personal Computer. It currently uses 486-based processors with EPP parallel ports and standard serial interfaces. You intend to employ commercially available CD-ROM portable readers to upload information specific to the E/F model into these engine testers.

Task: Review the interface standard information below, and perform comparative analysis to show advantages and disadvantages in terms of openness, performa … Then select the one you would use in this situation.

Circle the name of the interface standard you would specify

Technical Survey for External Peripheral Device Interfaces:

Name	Openness	Performance	Market Acceptance	Remarks
Standard Parallel Port	Based on the implementation by IBM in 1981 with a Centronics 36 pin connector.	Transfer Rate: 40-300Kbps Limited bi-directional capability - status signals only, not useful for reading from external devices	No longer in production, superseded by recent interface standards.	Parallel interface transfers 8 bits simultaneously
Standard Serial Port	Based on the implementation by IBM in 1981.	Transfer Rate up to 115 Kbps; Single device per connection Supports bi-directional communication	Older technology, now superseded by more recent ECP/EPP standards	Serial interface transfers 1 bit at a time
Extended Capability Port (ECP)	Joint Hewlett Packard/Microsoft specification	Transfer Rate up to 2,000 Kbps; Single device per connection Full rate bi-directional information transfer	Market Acceptance: In production on numerous systems with wide variety of vendors and customization available	Used primarily by new generation of printers and scanners. Backward compatible with parallel port standard.

(continued)

Name	Openness	Performance	Market Acceptance	Remarks
Enhanced Parallel Port (EPP), an IEEE version of ECP standard	IEEE 1284 (1994) Standard Signaling Method for a Bi-directional Parallel Peripheral Interface for Personal Computers	Transfer Rate up to 2,000 Kbps; Single device per connection Bi-directional information transfer	Market Acceptance: In production on numerous systems with wide variety of vendors and customization available	Used primarily by non-printer peripherals, CD ROM, tape, hard drive, network adapters, etc.. Backward compatible with parallel port standard
Universal Serial Bus (USB)	Universal Serial Bus Implementers Forum (industry group with open membership)	Transfer Rate up to 12,000 Kbps; Up to 127 devices per connection; Bi-directional information transfer	In production on Compaq, Digital, IBM, NEC, Sony, Intel, Microsoft and others. Products now appearing: joysticks, CD changers, digital cameras, videophone cameras, handheld scanners, mice.	Not backward compatible with earlier serial or parallel interfaces. Projection - peripherals now using parallel ports will move to USB. Expect to replace traditional serial and parallel ports in the next 3 years.
Apple "Fire Wire"	IEEE 1394 (1995) Standard for a High Performance Serial Bus Originally developed by Apple, now an IEEE Standard	Transfer Rate 100-400 Mbps; Up to 63 devices per connection Supports multi speed peripherals and bi-directional information transfer	In development	Capable of 2 simultaneous video channels and CD audio High cost, compared to alternatives

acquisition

reform

Week III

Solutions

Open Systems Concepts

Exercise Solution and Discussion Points

Analysis:

Standard Parallel Port (SPP). Old technology and out of production. Slow transfer rate and partial backward compatibility render this standard an unacceptable solution.

Standard Serial Port (SSP). Like the SPP, the SSP is an old standard and has a very slow transfer rate. Both the SPP and SSP have below average market acceptance and do not give us the benefit of lots of suppliers.

Extended Capability Port (ECP). A proprietary/unique standard developed by Hewlett Packard and Microsoft. ECP is backward compatible with parallel port standard, has an excellent transfer rate, and good market acceptance.

Enhanced Parallel Port (EPP). A fully open standard approved by the IEEE standards body. Excellent transfer speed, good market acceptance and is used primarily with CD ROMs. Fully backward compatible.

Universal Serial Bus. Implementers Forum standard is less open than IEEE standard. In production by several suppliers. Very high transfer speed, however this standard is not backward compatible.

Apple "Fire Wire." An open standard that evolved from a closed or proprietary status to an IEEE open standard. Highest transfer rate of all choices. Not much of a track record on this standard thus far as it is still in development. Will meet the requirement for backward compatibility, however does present a certain amount of risk at this stage in development and is the most expensive solution.

Best Choice:

Enhanced Parallel Port (EPP). An open standard which meets or exceeds performance requirements and has good market acceptance.